Evaluation of enclosure design, with focus on wild predators in Swedish zoos

Utvärdering av hägn, med fokus på vilda rovdjur i svenska djurparker

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Abstract

In today's modern zoos, there are five primary goals that are focused on: research, animal welfare, conservation, entertainment and education of the public. Entertainment is stated to be one of the main factors to why visitors come to zoos. In some cases these goals creates conflicts such as visitors may want to be close to and interact with the animals, whereas it might be best for the animal if it had more space to move around. In order to get a better understanding of the animals' welfare and ability to perform species specific behaviours, the design of the enclosures for the animals have to be taken in account. Stressors in the environment such as inadequate environmental designs can cause animals to perform unwanted behaviours such as stereotypic behaviours and this can decrease the animal welfare. Since no recent study have been made that investigates the enclosure designs in Swedish zoos, this master thesis focused on the housing of wild predatory animals in Swedish zoos. The overall aim of this master thesis is to compare Swedish regulations concerning enclosure design and environment of animals in zoos and the current enclosures in Swedish zoos, with a focus on housing of wild predators. Information about the enclosure design was collected through direct observations of enclosures combined with a questionnaire provided to the zoos visited. The questionnaire was designed to collect information regarding cleaning routines of the enclosures, whether any animals have health issues and if the zoo has extra space to care for sick animals or animals in need of extra attention among other things. The enclosure designs were then compared in relation to the Swedish regulations concerning housing of zoo animals (SJVFS 2009:92, Saknr L108) set by the Swedish Board of Agriculture. A total of 47 enclosures were observed in five different zoos located in the middle and south of Sweden. The overall results from this study shows that the enclosures on display for the visitors all meet the required standard in Swedish regulation. The barriers on each of the enclosures investigated are well designed for the species housed. Almost all of the enclosures provide suitable environments to promote performance of species specific behaviours, with a few exceptions, these being the limited possibility to hide for some individuals, or the opportunity to dig for others. In conclusion, this master thesis found that overall Swedish zoos do follow the Swedish animal welfare regulation on housing for zoo animals. The design of enclosures in Swedish zoos has not been thoroughly investigated. In order to understand the full extent of the way enclosures in Swedish zoos are designed, further studies on the design of enclosures and the way different designs affects captive animals is needed.

Sammanfattning

Dagens moderna djurparker fokuserar på fem primära mål: forskning, djurvälfärd, bevarandebiologi, underhållning och utbildning av besökarna, där underhållning är en av de främsta anledningarna till varför besökare kommer till djurparker. I vissa fall kan dessa mål leda till konflikter som till exempel att besökare vill komma nära och interagera med djuren, medan det i djurens fall kan vara bäst om dessa har mer utrymme att röra sig på. För att bättre förstå djurens välfärd och förmågan att utföra artspecifika beteenden måste man ta hänsyn till hur djurens omgivning är designad. Stressfaktorer i omgivningen som till exempel otillräcklig miljödesign kan orsaka att djuren utför oönskade beteenden såsom stereotypa beteenden och detta kan minska djurvälfärden. Det övergripande målet med den här studien är att jämföra den svenska förordningen angående inhysning av djurparksdjur med den befintliga inhysningen av djurparksdjur, med en fokus på inhysning av vilda rovdjur i Sverige, då ingen studie gjorts nyligen som undersöker hägns design i svenska djurparker. Information om inhägnadernas design samlades in genom direkta observationer kombinerat med ett frågeformulär som gavs ut till djurparkerna som besöktes. Frågeformuläret var designat för att samla information angående bland annat rutiner för rengöring av hägnen, om djurparken har problem med sjukdomar hos någon av arterna samt om djurparken har tillgång till utrymme för sjuka djur eller djur i behov av extra tillsyn. Designen av de inhägnader som observerades utvärderades för att se om dessa uppfyllde Jordbruksverkets föreskrift beträffande inhysning av djurparksdjur (SJVFS 2009:92, Saknr L108). Totalt observerades 47 hägn på fem olika djurparker belägna i mittersta och södra Sverige. De övergripande resultaten från studien visar att hägn med visning för besökare alla följer standarden som krävs enligt den svenska förordningen. Barriärerna på alla hägn som undersöktes är väl utformade för de specifika djuren som inhyses. Nästintill alla hägn är försedda med hållbara miljöer som främjar artspecifika beteenden, med ett fåtal undantag där dessa är begränsad möjlighet att gömma sig för vissa individer, eller möjligheten att gräva för andra. Sammanfattningsvis visar denna studie att i överlag så följer de svenska djurparkerna den svenska djurskyddslagstiftningen avseende inhysning av djurparksdjur, med undantag för vissa av de parametrar som undersöktes. Designen av hägn i svenska djurparker har ännu inte undersökts ordentligt, varken i tidigare studier eller helt i denna. För att få full förståelse för hur hägn i svenska djurparker är designade bör fler studier angående designen av hägn och hur olika inhägnaders design kan påverka djur i fångeskap göras.

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1. Introduction

The development of the scientific subject of zoo biology has undergone major changes in the last century, when the primary focus of zoos was to display exotic animals only for the restitution and amusement of the public society. Today, awareness of the critical situation of many wild species is acknowledged and the shift in priorities in zoos has led to a promotion in the work of saving species from extinction (Rabb, 2004). Zoos today do not only work with conservation programs within the park, but they are also involved in captive breeding. Zoos in Sweden and many zoos around the world have well adapted living conditions for the animals due to the extensive knowledge of the husbandry, behavior and veterinary resources that are connected to the different parks (Ryder & Feistner, 1995).

The biodiversity statuses on many of the species held in Swedish zoos today are closing in to extinction (Conde *et al.,* 2013). There are many different reasons for this, where poaching and illegal trading of animals are two reasons. Unfortunately, this will keep occurring as long as there is a market for illegal trading of wild animals (Archie & Chiyo, 2012). There is evidence indicating further decline in biodiversity given the current status on global warming, where many polar species are at risk if the current global warming trends do not change (Shrestha & Devkota, 2010). The same is applicable for the species whose habitats are threatened by urbanization (Seto *et al.,* 2012). It has been shown that to create sustainable conservation actions there has to be a combination of different approaches in the management of different species, where a combination of captive breeding, reintroduction programs and hunting restriction is the most effective and successful combination found (Hayward, 2011).

There are different ways of keeping animals in captivity, such as traditional zoos, safari parks, aquariums, oceanariums, marine parks, farm zoos, specialist collections and animal sanctuaries (Rees, 2011). Safari parks are larger enclosed areas where the visitors drive through the enclosure. Aquariums are large water tanks containing different species of fish for display, while oceanariums and marine parks are tanks with seascaped environment which can contain, inter alia, coral reefs and shipwrecks. The latter two types of confinements are more oriented towards displaying larger aquatic animals (*ibid.*). Farm zoos are typically seen in African regions where farmers have transitioned from traditional farming with little profit, to established private nature reserves with purchased big game species. Visitors can then pay to stay at tented camps or luxury lodges and view the animals from vehicles within the park. Specialist zoos are oriented toward keeping only species within particular taxa such as butterflies, insects or even otters. Animal sanctuaries are however larger enclosed areas where animals have been abandoned or rescued from zoos or in some cases unsuitable owners (Rees, 2011; National Geographic Society, 2017).

Even though there are many different ways of keeping animals, this master project will focus on traditional zoos in Sweden and specifically the housing of wild predators, due to the fact that many of the predatory species held in Swedish zoos are close to extinction. The project is also focusing on the challenges and benefits of the establishments today, as well as the physiological and behavioural needs of wild predators. The specific and detailed regulations concerning housing of animals in zoos are stated in by the Swedish Board of Agriculture (SJVFS 2009:92 Saknr L108). No recent study could be found concerning enclosure design of Swedish zoos.

2. Background

2.1. Illegal trading of wildlife

Wild animals have always been a big interest for humans where both predators and prey are included (Rosen & Smith, 2010). Due to urbanization in many countries where many exotic species are found, there has been an increase in the overall human-animal interactions which has led to conflicts because of reduction of living area available to the wild animals and an increase in living area for humans, where many wild species are threatened to be extinct (Seto *et al.,* 2012). Many years ago it was considered noble to own a wild exotic animal. It was common that royalties gave away exotic animals as gifts as well and for that purpose many wild carnivores were captured and sold in illegal trading (Rosen & Smith, 2010). This practice is unfortunately still ongoing even though there have been many attempts to put an end to it all.

Trading of wildlife is classified as exchange or sale of wild animals or plant resources provided by people. These animals or plants can be sold live or in parts in a range of different products prized or needed by different humans. There are a variety of reasons to why trading of wild animals is practiced, which include; food, clothing and ornaments, sport (e.g. falconry or trophy hunting), collections, religions or healthcare where different parts of animals are used as ingredients for industrial pharmaceuticals. The main reason for wildlife trading is the economic factor, since there are many different buyers that are willing to pay; from individuals to larger companies (TRAFFIC, 2008). In a wildlife trading assessment that was compiled by Rosen & Smith (2010) using 12 years of seizure records assembled by TRAFFIC (2008), they could see that the seizures included more than 191’934 live animals and that most of these animals were mammals of different species. Also mammal derivatives were popular trading items, which included skins, pelts and furs from mostly tigers and leopards (*ibid*.).

In 1975, a cooperation between several governments was founded and named CITES; Conservation on International Trade in Endangered Species of Wild Fauna and Flora. It is an international agreement and the aim is to monitor the global trading of wildlife and to take action if necessary on behalf of endangered species to ensure the survival (CITES, 1973; Lee, 1996). Today it involves 181 nations worldwide. CITES together with TRAFFIC conduct studies on trade, assist in investigations about illegal trade networks and recommend and conduct plans of action concerning how to manage wildlife trade in a sustainable and responsible way. These two organizations are together uniquely positioned to provide with the best data available (Rosen & Smith, 2010; Swedish board of Agriculture, 2016a).

2.2. Carnivores vs. omnivores

This study will focus on three different types of animal species, which include *ursidae, felidae* and *canidae*. There are many differences between carnivores and omnivores, where a few of those are the difference in feeding strategy, digestion and teeth composition. Although bears and canines eat meat, this is not their only source of energy intake. The feed of bears and canines comprises of many different energy sources such as: fruit, vegetables, berries, ants, hides and meat. This type of feeding strategy classifies both bears and canines to omnivores (mixed, opportunistic feeders). Felines on the other hand are classified as carnivores due to their strict

feeding strategy which comprises almost exclusively of meat (Cheeke & Dierenfeld, 2010). Both carnivores and omnivores are autoenzymatic digesters, which mean that they are able to secrete enzymes that are produced in their own body for use in the digestion (*ibid.*).

When looking at the teeth of carnivores and omnivores, they are classified into three different groups, where most carnivores are classified as *hypercarnivores*, which are dependent on a diet including at least 70 percent meat. Omnivores are classified as either *mesocarnivores* (at least 50 percent of diet includes meat) or *hypocarnivores* (less than 30 percent of diet includes meat). The teeth of hypocarnivores are mostly shearing blade carnassial teeth, with a few teeth used for grinding (molars) placed behind the sharper ones. These teeth are adapted for a diet made up of almost exclusively meat. Such strict hypocarnivores include the most extreme example which is felines (Wang, *et al.* 2008; National Geographic Society, 2016). The other croup is called hypocarnivores, due to their ability to eat other food sources as well as meat. Their teeth include shearing blade of the carnassial teeth, but they also have an enlarged area of grinding teeth (molars) behind the sharper ones. The most extreme example of hypocarnivore is the bear. Their diet is more varied and includes meat, fruits, roots, nuts, berries and insects. The third group of animals further used in this study is canids. Canids are not classified as either of the groups mentioned above, but classified as *mesocarnivores*, where 'meso' means 'middle' in Latin. When looking at the teeth of canids, they include more sharp carnassial teeth than hypocarnivores, but include more grinding teeth than the average hypercarnivore (*ibid*.). However, due to canids' ability to digest both meat and plants, they are classified in the same group as bears, which are omnivores (Cheeke & Dierenfeld, 2010).

2.3. What is the definition of a zoo?

There are several different definitions of zoos available and one of these is presented by the Swedish board of Agriculture (2016), where they describe a zoo as an establishment where animals are shown on display to the public society during at least seven days a year. The rules and regulations concerning zoos also includes other places displaying animals, such as restaurants, city parks and 4H-farms displaying animals (Swedish board of Agriculture, 2016b). The Swedish board of Agriculture also has directions which zoos in Sweden have to follow;

- All parks need permission to operate this kind of business, where they have to be approved by the County Administrative Board. The County Administrative Board inspects the enclosures where animals will be kept as well as if the staff is proper trained for the purpose.
- All parks have to keep in contact with a personal legitimated veterinarian as well as a zoologist. The veterinarian is responsible for treatments and care of the animals and the zoologist is responsible for advising the park about correct environments and feed for the different animals kept in the park.
- The animals on the different parks have to be able to express natural behavior, but not be able to harm themselves, other animals or visitors of the park.

- The animals have to be regularly checked upon, at least once a day. Most species have to be fed with fresh feed every day, although carnivores, fish, frogs and reptiles can be fed more seldom. This to promote normal and natural digestion. Water always has to be available and therefore regularly checked that it is fresh.
- If feeding animals at the parks with unprocessed animal rest products, certain permission have to be obtained. (*ibid*.)

A similar definition of a zoo is presented through Paul A. Rees book *An Introduction to Zoo Biology and Management* from 2011, by the European Union:

> … "zoos" means all the permanent establishments where animals of wild species are kept for exhibition to the public for 7 or more days a year…
>
> Council Directive 1999/22/EC (Zoos Directive), Article 2.

This definition includes traditional zoos, drive through safari parks, aviaries, snake parks, insect collections, aquariums, birds of prey centers and others, but excludes pet shops, circuses and laboratories which keep animals (Rees, 2011).

2.4. Stress and stereotypic behaviours in captivity

In today's modern zoos, there are five primary goals that are focused on. These goals are: research, animal welfare, conservation, entertainment and education of the public. Entertainment is however one of the main factors to why visitors come to zoos (Fernandez *et al*., 2009). When focusing on these five primary goals, there are many conflicts that can arise, such as that the visitors may want to be close to and interact with the animals, whereas it might be best for the animal if it had more space to move around. If and when the visitors cannot see the animals, fewer people come to the zoos, but since visitors are an important contributing factor to the zoos financial support, the zoos have to take their point of view in account when designing enclosures for the animals. Unfortunately, many visitors are very active and it can be very loud close to the different enclosures, and this is a big source of stress in zoo animals, which also creates a conflict in how to best house the animals (*ibid*.)

A relevant definition of the term "stress" has been provided by Morgan and Tromborg (2007) as "challenges to the tendency of systems to maintain a steady state, so called homeostasis, where any challenges to maintain homeostasis is called a "stressor"". There are many different types of stress factors that can be found in zoos, such as exposure to loud noises, artificial lighting, uncomfortable environmental temperatures, restricted movement abilities, lack of space, reduced retreat space, reduced feeding opportunities, abnormal group housings or a forced proximity to humans (*ibid*.).

There are generally two main types of stereotypic behaviour performed: the 'frustration-induced'- and the 'malfunction-induced' stereotypic behaviour. The frustration induced stereotypic behaviours are not the product of any underlying dysfunction, but instead driven by motivational frustration of repeated attempts to escape a confinement or to replace a lacking chance to perform a normal behaviour. The malfunction-induced stereotypic behaviours are

instead products of an abnormality in the C.N.S. functions that can co-occur with a suite of other affects with a motor pattern that is repeated without being very naturalistic, and which is also not reflecting the primary cause of the problem (Mason *et al.*, 2007).

Many captive animals often develop stereotypic behaviours, abnormal repetitive behaviours (ARBs) and/or abnormal non-repetitive behaviours that are uncommon and rarely observed in wild or free-ranging animals of the same species (Boorer, 1972; Carlstead & Shepherdson, 2000; Mason & Rushen, 2006; Mason *et al.*, 2007; Price, 2008.). Stereotypic- and other abnormal behaviour is described as an abnormal behaviour (atypical behaviour) with an exaggerated frequency and/or intensity of repetitive behaviour which arise due to stressors in the animal's environment. Many of the different stereotypic behaviours seen are components of normal behaviors directed towards inappropriate stimuli (Price, 2008), and they appear to have no function (Mason & Rushen, 2006). By performing stereotypic behaviours this could be a way for different animals to try to cope with their environment (Carlstead & Shepherdson, 2000; Mason & Rushen, 2006; Mason *et al.*, 2007). Mason *et al.* (2007) described that the 'coping' effects could arise because novel behaviour patterns that are developed in captivity may generate some or even all of the sensory/physiological feedback that is provided by full natural behaviour patterns. There are a number of different forms of stereotypic- and abnormal behaviours. The variation occurs due to difference in animal species and thereby needs. Some of the different forms include: walking the same route around the pen or cage, pacing back and forth the fence line, repeatedly walking in circles, inactivity/apathy, head-bobbing, bar-biting, neck twisting, tongue-playing, coprophagia, excessive grooming, self-mutilation or vomiting (Mason & Rushen, 2006; Mason *et al.*, 2007; Rees, 2011). Analyses by Mason *et al.* (2007) revealed that carnivores tend to perform mostly locomotory stereotypic behaviours, for example pacing. For *ursidae* kept outdoors, pacing has been shown to be the dominant stereotypic behaviour, while *ursidae* housed indoors have been shown to perform mostly oral stereotypes (Tan *et al.*, 2012). In another study conducted by Quirke *et al.* (2012), it was shown that if cheetahs were kept solitary, fed on predictable feeding schedule and/or have the ability to view other cheetahs in close by enclosures, this increases levels of stereotypic behaviour, while increasing the size of the enclosure decreased this behaviour. The results from the study by Quirke *et al.* (2012) were later shown again by Quirke and O'Riordan in 2015. This negative correlation between size of the enclosure and performance of stereotypical behaviours has also been found in zoo tigers (Breton & Barrot, 2014).

Even though the existence of stereotypic behaviour in animals is sometimes considered to be an indicator for poor welfare, it is unclear whether or not performing stereotypic behaviour in fact reduces the level of stress in the animal (Rees, 2011). Instead, welfare and well-being of zoo animals can be assessed by studying variables indicating poor welfare, which can be infertility, stillbirths, productiveness, infant mortality and adult survivorship together with the performance of stereotypic and other abnormal behaviour (Mason & Veasey, 2009). Although there is generally a negative view towards stereotypic behaviours, it may not only be seen that way. It is important that the animal is displaying this type of behaviour for three main reasons. The first reason is that the performed stereotypic behaviour may indicate a poor welfare, which raises ethical concerns leading to actions taken. The second reason is that the animals that are

performing stereotypic behaviour may have some kind of C.N.S. dysfunction, since animals with a dysfunction often perform behaviours that differ from normal behavioural patterns that are not shown by free living animals of the same species. The third and last reason is that animals living in captivity can be compared to free-living animals of the same species, which can ultimately be used to see how captivity can affect the animals' behaviours (Mason *et al.*, 2007).

2.5. Environmental enrichments

Zoo animals have not been specifically selected for adaption to captive environments, but instead zoos today strive toward avoiding genetic changes in the captive populations of wild animals (Carlstead & Shepherdson, 2000; Rees, 2011). The goal is to raise animals that behave 'normally' according to criteria based on the behaviours shown by their free-living conspecifics. The goal is to maintain genetic diversity within captive populations, should there be the need to at some point in the future use some of the captive animals as a source for reintroducing animals into the wild. Thus, for captive propagation to be successful it is important that endangered captive animals are able to live productive lives with a full range of 'natural' behaviours and also to produce normal captive-born offspring (Carlstead & Shepherdson, 2000). As mentioned earlier, conservation is one of the five primary goals that zoos are working to uphold. In order for the animals to behave naturally, their captive environment therefor needs to be enriched to uphold certain standards, depending on what type of animal is housed. This type of enrichment is referred to as 'environmental enrichments' and is a tool used by zoos to promote behavioural diversity (Rees, 2011).

Environmental enrichments should not be mistaken as behavioural enrichment, since the term environmental enrichments is to be preferred as enrichment may contribute to benefits other than changes in behaviour, for example improved reproductive success (Rees, 2011). A short definition of the term 'environmental enrichment' has been proposed by Shepherdson (1998) as:

> "…an animal husbandry principle that seeks to enhance the quality of captive animal care by identifying and providing the environmental stimuli necessary for optimal psychological and physiological well-being."

Enrichments in general includes many different types and may consist of devices, practices and techniques that will keep the animal occupied and can increase the diversity and range of behavioural opportunities. The different types may include: hiding of feed, freezing feed into blocks of ice, feeding devices, training or using natural vegetation and substrates in the enclosure. By using enrichments there can be a lot of benefits for the animals such as: promotion of natural (species specific) behaviours, opportunities for exercise, opportunities for learning new things, provide mental stimulation and an increased control of the environment and thereby reduce the level of stress (Rees, 2011). Unfortunately it seems that environmental enrichments are only partially successful in reducing the level of stress in zoo animals in zoos today. This is suggested to be due to either that the chosen enrichment was not entirely optimal or that the

enrichment was introduced to late, when the abnormal behaviours already have become resistant to change (Mason *et al.*, 2007, Quirke *et al.*, 2012).

An enclosure consists of many different enrichments for the animals, but only the different environmental enrichments that are considered specific for each species are included in the Swedish regulation (SJVFS 2009:92) concerning animals in zoos. *Ursidae, felidae* and *canidae* in Swedish zoos are the main focus of the study and the requirements according to the Swedish regulation can be found in appendix 2.

2.6. Enclosure design

There are many different ways to design an enclosure. It is important to design the enclosure according to the needs of the specific animal species housed in the enclosure, but it is also important to take the animal keepers and the visitors' needs in account in order to create a sustainable and functional enclosure (Fernandez *et al.*, 2009). When designing an enclosure it is important for the animal to be able to walk away from the visitors, but it is also important to design the barriers so that it results in a rewarding experience for the visitors (Figure 1). By including elements found in the normal habitat for the wild conspecifics, this can serve as a type of shelter for the animals, but also educate the visitors about the animals' natural state of living (*ibid.*). Depending on what species is exhibited, the barriers can be of different designs.

Figure 1. ***Grey wolf*** *(Canis lupus) enclosure containing natural elements and possibilities to hide.*

Figure 2. *Vertical fence with return on the top.*

There are essentially seven different types of barriers used for predators in modern zoos, but these types may be combined to create more appropriate barriers for the specific animal housed. These types of barriers include: fences, concrete walls, glass,

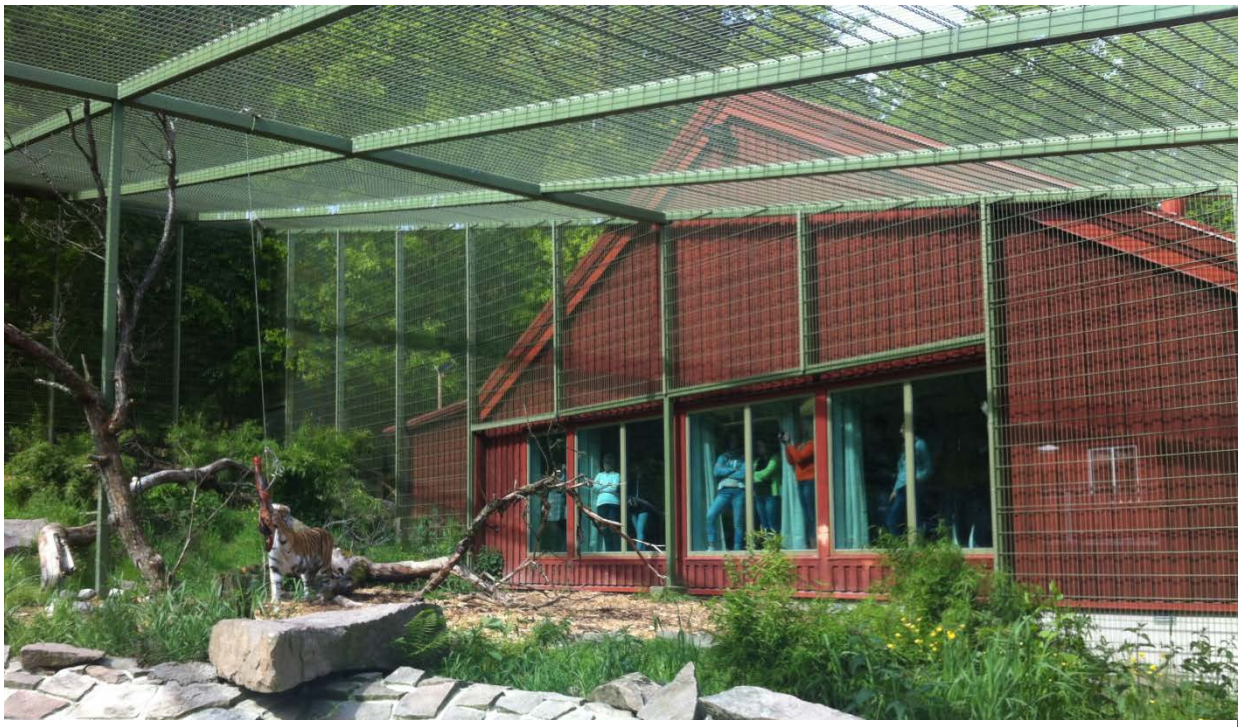


Figure 3. *Strong barriers for large felidae with a cover on top to prevent escape.*

moats, ha-has, mountain walls or wooden boards (Rees, 2011). For large felines for example, it is important to have strong barriers that can protect both the visitors and the animals. It is also important to keep the enclosure interesting for the visitors, which is why a combination of strong fences such as iron grilles and glass windows are a good choice. These barriers are often vertical fences with a return on the top and can be reinforced with an electric wire (or barbed wire) running along the return on the top (Figure 2). If the housed animal is good at climbing, it may also be necessary to cover the top of the enclosure with netting or wire mesh in order to minimize the risk of the animals escaping (Figure 3). It is also possible to reinforce the bottom part of the fence, along with any climbing material such as trees inside the enclosure, with for example metal sheets, fiber glass or some other smooth material (Gupa, 2008, Rees, 2011). Electric wire can also be favorably used to prevent the animals from destroying ornamental vegetation, climbing trees/fence or touching the outer barrier. Since electric wire is never used as a single barrier for predators, it works as a secondary barrier, and is often put both on the inside and outside of a barrier such as fence. When using electric wires, these should be indicated by appropriate signage (Rees, 2011) (Figure 4).

Figure 4. *Proper signing of electric fence.*

Moats can be used either dry or wet, and are fairly similar to ha-has. Dry moats are more common to use for large, non-jumping animals such as elephants or rhinos, while wet moats can be used for animals who does not like water such as gorillas. Wet moats are typically reinforced with electric fencing on either side of the water to prevent the possibility to escape. However, the moat should be shallower on the animals' side, in case the animal accidentally falls in or is being pushed in. The ha-ha on the other hand is a concealed barrier where a section

of the ground slopes down toward the outer parts of the enclosure, and which meets a higher concrete wall. This puts the animal in the enclosure at the same eye-level as the visitors and can create a feeling that there is no barrier present. However, there is a distance created between the visitors and the animals which creates a dilemma when visitors want to be close to the animals (Rees, 2011). While wet moats can be a good barrier choice for tigers, it is not appropriate for lions since lions have been reported to have drowned in the moat water (Gupa, 2008).

There are also different viewpoints found in a zoo, depending on what type of animal displayed. These different viewpoints can be classified according to their location: ground level, high level, subterranean (dens and setts) or underwater (pools and ponds). The different types of viewing points can then be different depending on the level of the viewing point: windows (wolves, tigers, lions, lynx, etc.), boardwalks (ground level for lemurs and high level for cheetahs and wolves) (Figure 5) or remote (periscope used on high or low levels) (Rees, 2011).

Figure 5. Viewing point - *High boardwalk.*

2.7. Aim

The overall aim of this master thesis is to compare Swedish regulations concerning enclosure design and environment of animals in zoos and the current enclosures in Swedish zoos, with a focus on housing of wild predators. With the information gained from different zoos in Sweden, we can better understand the way carnivores in Sweden are currently housed and get a better understanding to what might need to change, or what seems to be working, within the enclosures.

The specific aims are to:

- Map and describe typical predator enclosure design in Swedish zoos.
- Investigate possibilities for different species of predators to express species-specific behaviours in the present enclosures.
- Compare the present predator enclosure design in Swedish zoos to the Swedish regulation set by the Swedish Board of Agriculture (SJVFS 2009:92, Saknr L108)?

3. Materials and description of the enclosures

Standardized protocols were used to assess the enclosure designs during a period of two months on five zoos in Sweden. The observations took place during the months of May and June in the year 2015, and the parks visited are located in the middle and southern parts of Sweden. In order to evaluate the enclosures for wild carnivores in the different zoos, a standardized protocol was used for all the different enclosures. The design of the protocol was established to reduce subjective measures in order to minimize the human bias and the protocol was tested during a pilot observation at a zoo in Sweden in order to modify and improve it until the actual study

started. The information that was gathered using the protocol (appendix 2) was concerning barrier type, enclosure design, housing, ground substrate and ability to perform species specific behaviors. Relevant literature was also used in order to evaluate the ability for the animals to perform species specific behaviours. A total number of 47 enclosures were observed during the observation period and there was one protocol used for each enclosure.

Since there are some parameters that are included in the Swedish regulation concerning zoos that could not be included in the protocol, these questions were given as a questionnaire to each of the zoos visited in order to collect more specific answers. This questionnaire included the following questions:

- Are there a veterinarian and a zoologist connected to the zoo?
- Does the zoo have an enclosure for sick animals or animals in need of extra attention?
- Do the predatory animals have any heath or behavioural problems?
- Are the enclosures cleaned regularly?
- Does the zoo provide any enrichment for the predatory animals? If yes, what type?

Table 1. *Animals observed in the study*

Animals
African wilddog *(Lycaon pictus)*
Amur leopard *(Panthera pardus orientalis)*
Arctic fox *(Vulpes lagopus)*
Brown bear *(Ursus arctos)*
Cheetah *(Acinonyx jubatus)*
Clouded leopard *(Neofelis nebulosa)*
Dhole *(Cuon alpinus)*
European wild cat *(Felis silvestris silvestris)*
Fossa *(Cryptoprocta ferox)*
Gray wolf *(Canis lupus)*
Jaguar *(Panthera onca)*
Lion *(Panthera leo)*
Lynx *(Felis lynx)*
Maned wolf *(Chrysocyon brachyurus)*
Pallas's cat *(Otocolobus manul or Felis manul)*
Persian leopard *(Panthera pardus ciscaucasica syn. Panthera pardus saxicolor)*
Raccoon *(Procyon lotor)*
Red fox *(Vulpes vulpes)*
Snow leopard *(Panthera uncia syn. Uncia uncia)*
Spotted Hyena *(Crocuta crocuta)*
Tiger *(Panthera tigris)*
Wolverine *(Gulo gulo)*

Since none of the species observed could be found in all five zoos that were visited (Table 1), there has been a selection of species in order to highlight some important aspects of the study. The species used further on in this thesis are representative for the wild predators kept in

Swedish zoos. The results from the study are compared with the current regulations concerning keeping of zoo animals provided by the Swedish Board of Agriculture, which can be found in SJVFS 2009:92, Saknr L108.

4. Results

4.1. Overall management of predators

Four out of five zoos responded to the provided questionnaire. All five zoos visited reported that they had a veterinarian and a zoologist connected to the zoo. All five zoos also reported having additional enclosures for sick animals or animals in need of extra attention. When questioned about the health of the animals, only one zoo out of five responded that they have any health issues with their animals where they reported having annual problems with a certain animal population, in this case Pallas cat. The zoo reported that the Pallas cats are carriers of toxoplasma and that this affects the offspring so that they often die before 6 months of age. The same zoo also reported having issues with their European wildcat population, where the cats lose their teeth.

All zoos that responded to the questionnaire (four out of five) reported that they clean the enclosures: two zoos reported cleaning on a regular basis, the third zoo could not respond how often and the fourth zoo reported cleaning at least once a year. All the responding zoos also reported that the different enclosures where cleaned with different frequencies, where the most frequent were enclosures for bears and canids (every day and every other day).

4.2. Enrichments

Four out of five zoos reported on the questionnaire that they used some type of enrichment for the enclosures, where three zoos out of five had a regular schedule on how often to provide new enrichments in the enclosures and one zoo only mentioned that enrichments were provided but did not specify on what type for each animal species.

Table 2. *Percentage of enclosures observed that were given* e*nvironmental enrichments, excluding the stationary enrichments in the enclosures.*

Enrichment type	Percent of enclosures receiving the type of enrichment
Feed – hanging	42%
Feed – spreading	38%
Feed – bigger parts of an animal	42%
Feed – whole animals	46%
Feed – hiding or tying	50%
Feed – in water	12%
Scent	54%
Pelts	31%

Other things	35%

The data concerning feed used as enrichments in different enclosures were only taken from three out of five zoos, since two out of five zoos did not respond to what types of enrichments were used in the different enclosures. A total number of 47 enclosures were observed during the study, but only 26 enclosures were specified given some type of feed enrichment. Many enclosures were given several different enrichments for variation.

4.3. Ability to perform species specific behaviours

Zoo animals have species specific behaviours that need to be taken in account when designing an enclosure. Therefore the Swedish Board of Agriculture has provided regulations concerning the design of enclosures for specific animals housed in zoos (SJVFS 2009:92, Saknr L108). The specific requirements can be found in appendix 2. The three groups of animals that were focused on when looking at specific behavioural needs were: Felines, canids and bears.

For felines the regulation includes material in the environment which provides the animals an opportunity to: hide, keep a lookout and climb. It was found that in 78% of the enclosures observed that housed felines, the animals had a big possibility to walk away from visitors and hide, 13% could not hide very well and 9% of the enclosures did not provide any place for the animals to hide (Figure 6). In 100% of the enclosures observed with felines, the animals had a big possibility to lookout (Figure 7). For 91% of the enclosures observed with felines there was a big opportunity for the animals to climb, whereas 9% of the enclosures did not provide any climbing opportunities (Figure 8).

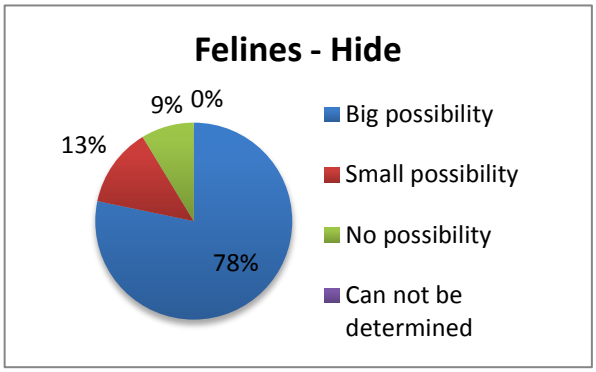


Figure 6. *The percentage of enclosures observed for felines that provides an opportunity for the species specific behaviour hide.*

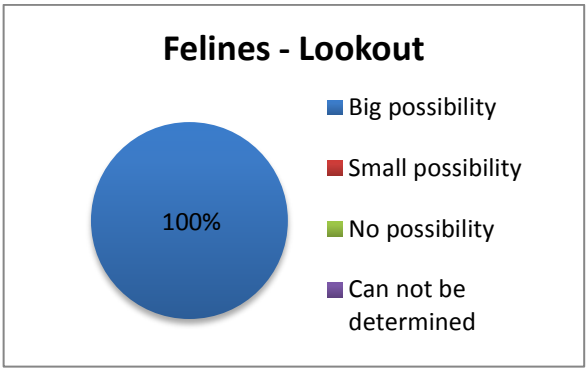


Figure 7. *The percentage of enclosures observed for felines that provides an opportunity for the species specific behaviour lookout*

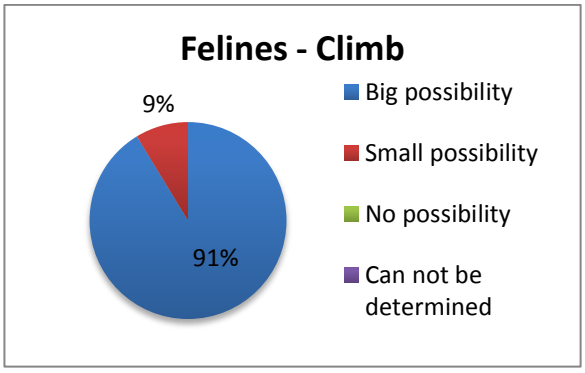


Figure 8. *The percentage of enclosures observed for felines that provides an opportunity for the species specific behaviour climb*

For canids the regulation includes material in the environment which provides the animals an opportunity to: have social interactions, possibilities to dig and to keep a lookout. In 88% of the enclosures housing canids there was a big possibility for the animals to engage in social interactions, and for 12% of the enclosures housing canids there was no opportunity for this behaviour (Figure 9). 100% of the enclosures observed which housed canids there was a possibility for the animals to dig (Figure 10). Also for 100% of the enclosures observed, there was a big opportunity for the animals to keep a lookout (Figure 11).

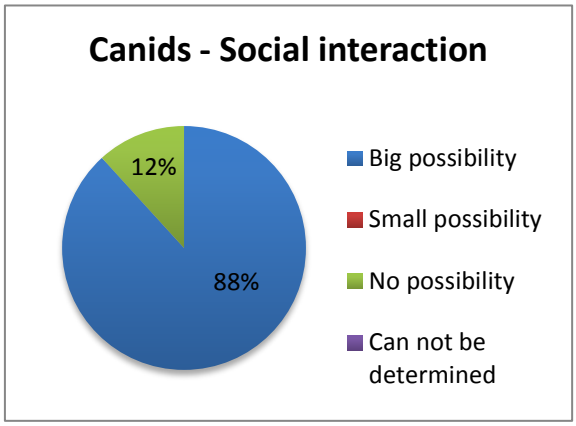


Figure 9. *The percentage of enclosures observed for canids that provides an opportunity for the species specific behaviour social interaction*

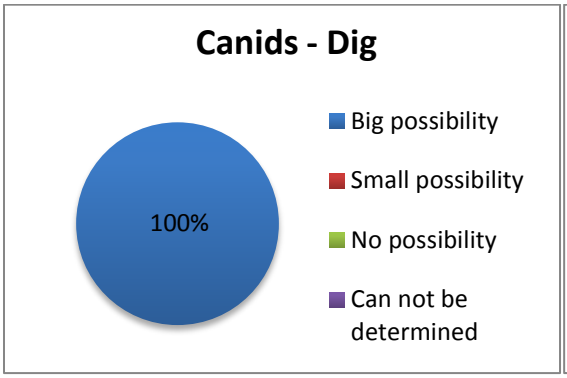


Figure 10. *The percentage of enclosures observed for canids that provides an opportunity for the species specific behaviour dig*

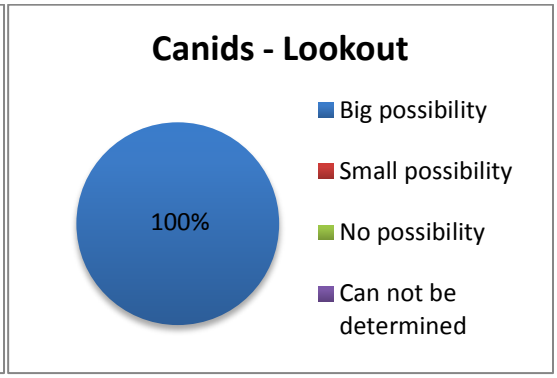


Figure 11. *The percentage of enclosures observed for canids that provides an opportunity for the species specific behaviour lookout*

Lastly, for bears the regulation includes material in the environment which provides the animals an opportunity to: have social interactions, possibilities to dig and climb. In 80% of the enclosures observed which housed bears, there was a big possibility for the animals to engage in social interactions, while for 20% of the enclosures there was a small possibility for this behaviour (Figure 12). For 80% of the enclosures with bears there was a big possibility for the individuals to dig, and for 20% this possibility was small (Figure 13). 100% of the enclosures provided the possibility for the individuals to climb (Figure 14).

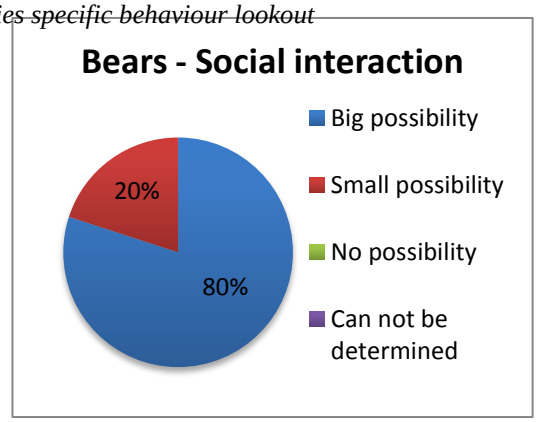


Figure 12. *The percentage of enclosures observed for bears that provides an opportunity for the species specific behaviour social interaction*

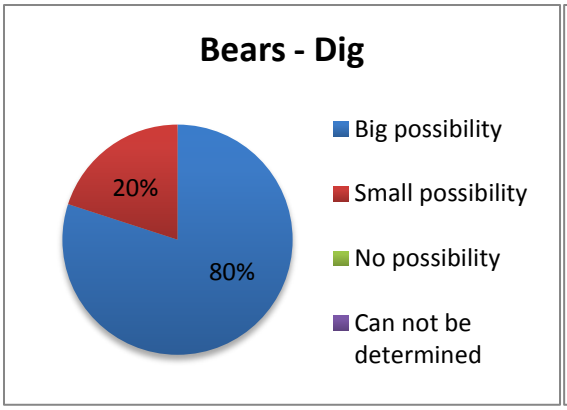


Figure 13. *The percentage of enclosures observed for canids that provides an opportunity for the species specific behaviour dig*

Figure 14. *The percentage of enclosures observed for canids that provides an opportunity for the species specific behaviour climb*

4.4. Enclosures with display

A total of 47 enclosures in five different zoos were observed at the time of the study. The information gathered in the protocols was used to evaluate the current condition and design of the enclosures.

4.4.1. Barriers

A total of 47 enclosures with display were observed. 19 of the enclosures observed housed canids, 23 enclosures housed felines and 5 enclosures housed bears, where 2 enclosures for bears housed males individually. The dominant barrier type observed was mesh fence (28%), followed by concrete combined with mesh fence (19%) and mesh fence and glass (15%) (Figure 15). The other barrier types observed were: concrete and glass (13%), concrete combined with glass and mesh fence (6%), concrete combined with glass and mountain (4%), mesh fence and mountain (4%), iron grilles (4%), concrete (2%), mesh fence and wooden boards (2%) and concrete combined with a moat (2%).

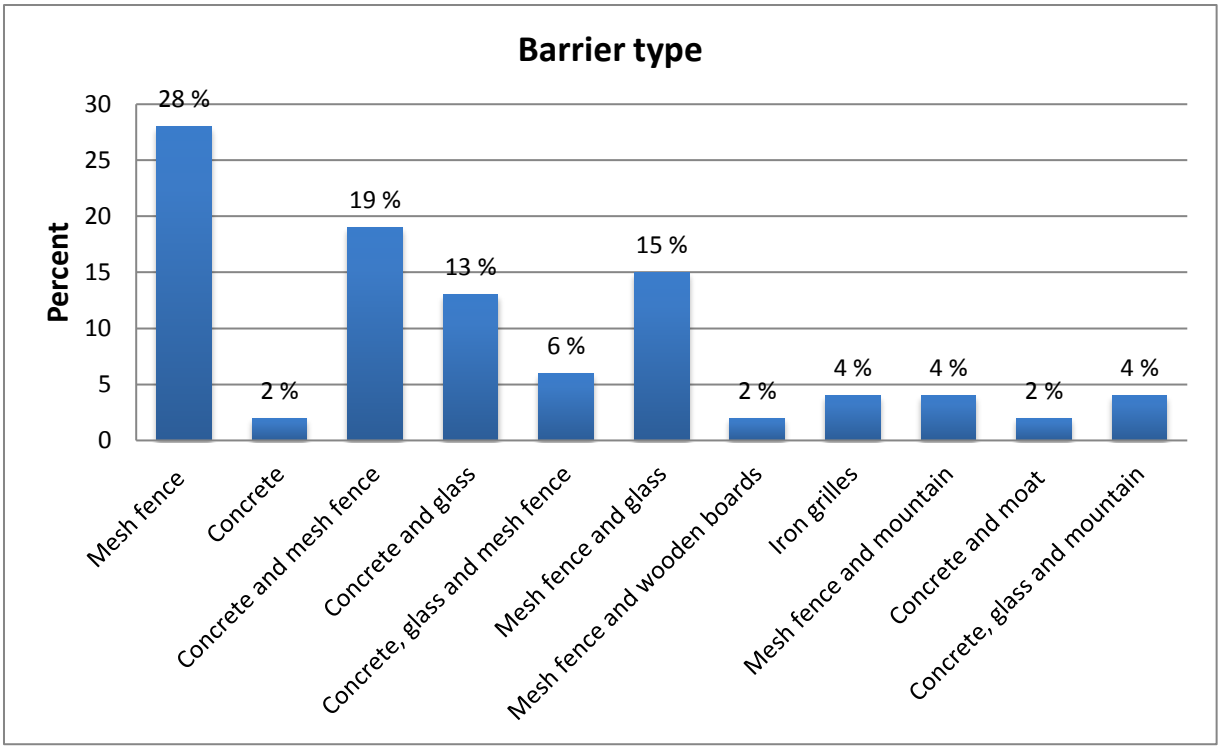


Figure 15. *Barrier types used to contain predators in Swedish zoos.*

4.4.2. Visitors access to barriers and visibility of enclosure

In 4% of the enclosures observed, the visitors had full access to the enclosures barriers (Figure 16). For 13% of the enclosures 75% of the enclosure was accessible to the visitors and for 11% of the enclosures the visitors had access to 66% of the barriers. 23% of the enclosures gave a 50% access to the barriers for the visitors and 13% of the enclosures provided a 33% access to the barriers. The dominant amount of access the visitors had to enclosures was 25%, which was the case for 36% of the enclosures observed. None of the enclosures observed provided 0% access to the barriers.

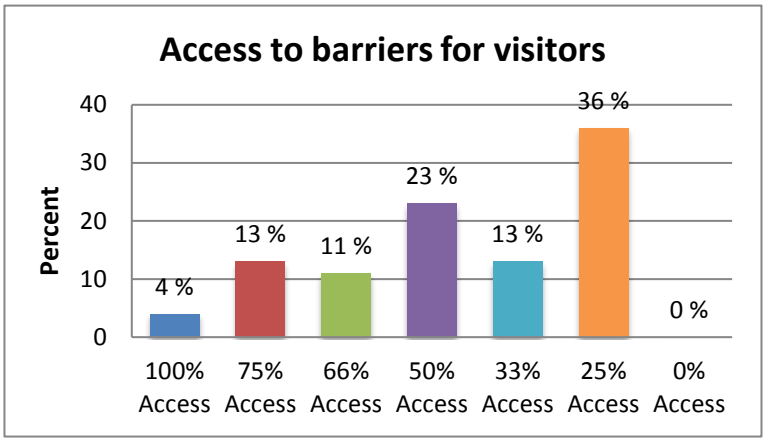


Figure 16. *Visitors access to the barriers of all enclosures observed*

For most of the enclosures observed, the visitors could see more than half of the entire enclosure (60-90%) (Figure 17). In 28% of the enclosures, the visitors had full visibility to the enclosure and for 15% of the enclosures observed the visitors had 20-50% visibility. None of the enclosures observed provided 0-10% visibility for the visitors. In 94% of the enclosures, the animals could move out of the visitors view, and in 6% of the enclosures they could not (Figure 18). The majority of animals that could not move out of view from the visitors were felines.

Figure 17. *Percentage of the enclosures visibility for the visitors including all enclosures observed*

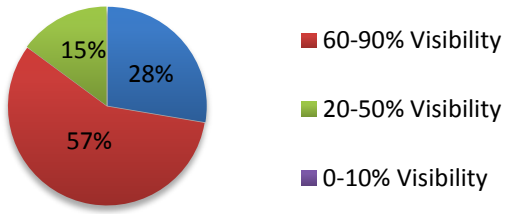
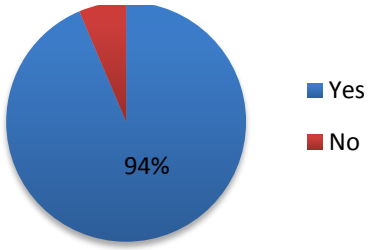


Figure 18. *Percentage of all enclosures providing retreat space for the animals housed.*



4.4.3. Ground substrate

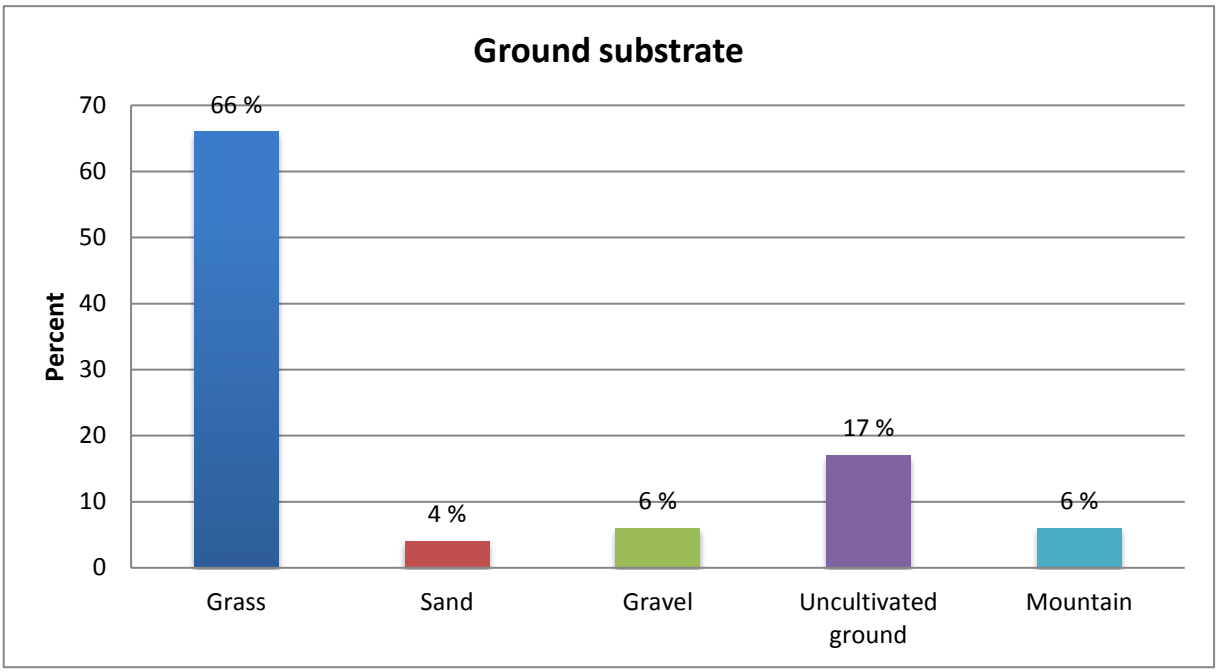


Figure 19. *Main ground substrate in all the enclosures observed.*

When investigating the ground substrate it was observed that the dominant part of the enclosures' ground substrate mostly comprised of grass (66%); both natural grass and placed lawn grass (Figure 19). In 17% of the enclosures, un-cultivated ground was the main ground substrate. Both gravel and mountain surface was the main ground substrate in 6% of the enclosures each. Sand was also used in 4% of the enclosures as the main ground substrate.

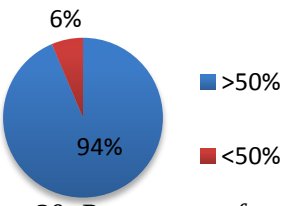


Figure 20. *Percentage of enclosures providing more or less than 50% soft grounds.*

In addition to ground substrate, it was also investigated whether or not the enclosure provided 50% soft grounds (Figure 20). It was found that in 94% of the enclosures, more than 50% of the ground was soft. The additional 6% of the enclosures investigated provided less than 50% soft grounds.

5. Discussion

The purpose of this study was to compare the current enclosures in Swedish zoos with the Swedish regulations concerning enclosure design, with a focus on housing of wild predators. To achieve this, five zoos were visited and the enclosure designs for predators were assessed to investigate whether or not Swedish zoos follow the regulations set by the Swedish Board of Agriculture. Due to lack of time and financing, only five zoos in Sweden could be visited during the time of this study. The questionnaire used in this study was provided to each zoo, either by interview or by e-mail, but not all zoos answered this. Because of lack of response from some of the zoos and not complete answers from other, the information on the questionnaire is quite limited and it made the assessment very difficult, since there was in some cases very little or nothing to compare with the Swedish regulation.

The overall results from this study shows that the enclosures on display for the visitors all meet the required standard in Swedish regulation and that they are well managed. The barriers on each of the enclosures investigated are well designed for the species housed. Almost all of the enclosures provide suitable environments to promote the species specific behaviours, with a few exceptions, these being the limited possibility to hide for some individuals, or the opportunity to dig for others. In zoos, it is difficult to provide a large enclosure to meet the normal standards of the wild conspecifics, since many of the animals have territories which stretches many kilometers (Rees, 2011).

It has been shown that there is a negative correlation in zoo animals between the size of the enclosure and the performance of stereotypic behaviours (Clubb & Mason, 2007, Mason *et al.,* 2007, Quirke *et al*., 2012, Breton & Barrot, 2014). In 2007, Clubb and Mason presented a study where they suggest that the welfare of many zoo animals, in particular carnivore species, is compromised due to inadequate enclosure sizes. They stated that the stereotypic level and relatively high infant mortality rates in captive animals are related to natural ranging behaviour. They found that animals with a large ranging area in the wild tended to have a higher infant mortality rate in captive environments than those with smaller ranging areas. They also found that the stereotypic behaviour pacing is more likely to occur in captive animal species that in the wild have a large median daily travel distance than in those species that travel shorter distances. Clubb and Mason (2007) suggest that when designing new enclosures for carnivorous animals, one should focus on their natural ranging behaviour and thus design the enclosure where the animals for example have a larger space to move in, multiple den sites and a greater day-to-day environmental variability.

It has been argued that even though zoo animals and free-ranging conspecifics may be able to perform the same behaviours, the triggers and needs for some behaviour might be different, resulting in that zoo animals might not need to perform certain behaviours that can be seen in

their wild conspecifics (Veasey *et al.*, 1996). Thus, by only assuming that zoo animals are not showing the same behaviours as wild conspecifics is a sign of poor welfare, this might not be an accurate tool to assess the welfare of zoo animals, but may only work as a part of a more complex way to measure the welfare of zoo animals.

Not only endangered wild species are displayed in traditional zoos, but many indigenous breeds of domesticated animals are shown in Sweden, such as cows, goats and sheep. It is also common in Swedish zoos to house species like brown bear, grey wolves and red foxes, which are classified as non-endangered, but still interesting for the visitors to see, since these are species found wild in the Swedish forests. The goal with displaying these species is assumed to be to increase the awareness of the animals living in Swedish forests, in order to preserve and increase interest in maintaining our Swedish forests habitable for these types of species.

5.1. Responses to the provided questionnaire

When questioned about sick predators in the zoos, only two zoos responded to this question, where one zoo mentioned that they train the animals and at the same time look for injuries, and the other zoo that responded was the only zoo to give an answer about what type of illness their animals often are treated for. It is possible that the zoo staff responding to the questionnaire did not know what animals were sick or what they were treated for.

The question about enrichments in the questionnaire only four out of five zoos responded to where they reported using some type of enrichment for their predators. When observing the predators in the zoo which did not respond to the questionnaire, many of the different enclosures displayed several enrichments for the animals. But since this zoo did not respond to the questionnaire this information was not used in the results. The other zoo which did not state in the questionnaire what type of enrichment they used in the different enclosures was also excluded from the result. As mentioned, a total number of 43 enclosures were observed during the study, but only 26 enclosures were specified given some type of feed enrichment and these are included in the result concerning enrichments given other that the stationary (Table 2).

Hanging feed was most often tied higher up in a tree or on a wire between two trees, but was for some species used on a fishing rod. Spreading feed was mostly fruit or dog feed. Dog feed was a common source of energy for some of the animals. The animals reported given dog feed in forms of dry- or wet pellets were: arctic fox, red fox, maned wolves, grey wolves and bears. When using bigger pieces of an animal, it was mostly reported that these were tied for two reasons: the first being that the animals had to work harder in order to receive the reward of feed, and the other being that it is easier to clean the enclosure if the leftovers are at a certain place so that it does not have to be searched for.

When fed whole animals, these included rabbits (most often used for cheetahs), chickens (most often used for the smaller cat species such as Pallas cats or European wild cat but also for raccoons and the smaller canid species such as arctic fox and red fox), fish and mouse. When hiding the feed it was done in a few different ways at the zoos: hiding it under something, digging it under ground, hiding it in something (for example a ball with holes or a log). Feed in water was mostly thrown in the water for the animals to seek up, but in some cases feed was

frozen and could be found in the middle of a chunk of ice. This allowed the animals to work hard for their reward. Not only pieces of meat were reported being frozen, but blood from prey animals was used as well. Frozen feed was also mostly reported to be used on bears and wolverines.

When using scents for the animals, it was reported that the zoos used several different scents in order to keep it interesting for the animals, where one or two scents were used at a time. The scents were reported to either be put in different spots in the enclosure, or to be put in a scent trail for the animals to follow. The scents reported included: blood, fecal from other predators, perfumes, scented oils or spices (curry, ginger and cinnamon). One zoo reported using men's after shave and perfume (Dolce & Gabbana) for their wolverines because this was most effective and preferred according to the zoo. Pelts were reported being used in three different ways: tied to something in the enclosure, hanging or put in a clamp so that the animals did not have fully access to the pelt. Other things reported used as enrichments include: Wool, cartons, rope, logs, fir, pumpkin, melon, live insects, tiers, boomer ball, leaves, dirt, fresh cut grass, hay, straw, silage, moss, feathers, popcorn, pig ears, eggs and pipes with holes.

The question on the questionnaire about enrichments was meant to see if the zoos were using any type of feeding enrichments or enrichments which were not always visible for visitors. During observation any other enrichments used in the enclosure was noted, such as laying areas, ground substrate, climbing material etc..

5.2. Species specific behaviours

From the regulation concerning housing of zoo animals provided by the Swedish Board of Agriculture, the protocol used in the study was designed to investigate if the animals certain species specific requirements were met. These included felines' possibility to hide, climb and have a lookout, canids' possibility to dig, have social interactions and have a lookout and bears possibility to dig, have social interactions and climb.

The results shows that some bears have a small opportunity to have social interactions (figure 12). These individuals social interaction possibility was assessed to be small because these individuals were not housed together with any conspecifics, but instead red foxes which seemed to be a popular way to house male brown bears. Although these bears are not housed together with any conspecifics, they had some chance of social interactions.

The retreat spaces available for the animals were only counted if the animal had the possibility to move away from the visitors view. These type of places included dense trees, big rocks, hills and shelters. In 6% of the enclosures observed, the animals did not have to opportunity to escape the visitors view. By constantly being available to the visitors, this can cause stress in the animals on display (Morgan and Tromborg, 2007) and ultimately lead to performance of stereotypic behaviours (Mason *et al.*, 2007, Price, 2008). In all the cases where the animals had a forced proximity to humans, the visitors had full view of the enclosure. In these enclosures the full access to the animals was either due to that the shelters were facing towards the visitors instead of away from the visitors, or the visitors had full access to the barriers and could thus walk around the enclosure and look from several viewpoints.

5.3. Enclosures with display

5.3.1. Barriers

The most popular barrier type was mesh fence, which was the case for 28% of the enclosures. The choice of using this type of barrier may be due to it being cheap, easy to construct and can hold a variety of species (Rees, 2011). A combination of mesh fence and concrete was used for many climbing, but not high jumping animals such as bears and wolverines. When glass was added to this combination for some of the enclosures, the glass served as a viewing point for the visitors as a chance to get closer to the animals than what the otherwise would have without the glass barrier. The use of mountain as a barrier is a way for the zoos to incorporate natural environment to the enclosure. This makes the enclosure look more natural than if a concrete wall were to be built instead.

5.3.2. Access to barriers

The most common amount of access the visitors had to the barriers were 25%, since many of the enclosures only offered view from one side of the whole enclosure. In the cases where the visitors had 100% access combined with 100% visibility of the enclosure, gave the result that 6% of the enclosures did not provide any retreat space for the animals.

In some cases the visitors could have full access to the barriers, but not 100% visibility of the enclosure due to a group of trees of bushes in some part of the enclosure which provided an opportunity for the animals to walk away from the visitors view and thus, providing a retreat space.

5.3.3. Ground substrate

Grass was the dominant type of ground substrate (66% of the enclosures), which was either planted or naturally growing. The other common type pf ground substrate was uncultivated ground, such as forest ground with roots, rocks and moss as the main substrates included. For the enclosures with mainly mountain surface as ground substrate, the reason was because the zoo was partly built on and/or around a mountain.

It is stated in the regulation that for many of the animals soft ground should be provided in at least 50% of the enclosure. In 6% of the enclosures observed, less than 50% soft ground was available. This was in all of the cases due to the enclosure being put on a mountain surface.

6. Conclusion

In conclusion, this study found that overall Swedish zoos do follow the Swedish regulations on housing for zoo animals. Due to the inadequate responses from some of the zoos, assessments on whether or not the zoos follow the Swedish regulations to the full extent could not be investigated. However, direct observations of the enclosures could be used to assess the general state of the enclosures which showed an overall good design of the different enclosures and that most of the animals had a great possibility to perform species specific behaviours due to the design and environment in the enclosures. In the cases where some of the animals did not have an optimal environment, the animals had either a forced proximity to the visitors where they

did not have any chances of moving out of view from the visitors, the enclosure did not provide enough soft ground or that the animals did not have adequate climbing possibilities. The possibility for animals to move out of view from visitors has been shown to decrease the level of stress in captive animals and also providing a more natural environment for the animals, and should thus be strived towards. The design of enclosures in Swedish zoos has not been thoroughly investigated. In order to understand the full extent of the way Swedish zoos are designed, further studies on the design of enclosures and the way different designs affects captive animals should be made. This master's thesis is a good base for further studies in the same area, which with better resources, could expand this area of investigation to include comparisons of housing specific species between countries and the level of which the regulations are set between countries, along with other interesting topics.

7. Acknowledgements

Two of my favorite topics to write about are animal behaviour and welfare of animals. I think it is fascinating to study animals, and especially wild ones. I find it very interesting and try to get a better understanding of captive wild animals and their needs and requirements. By investigating the enclosure design in this study, it has given me further knowledge on how wild animals are taken care of in captivity and I am grateful for the opportunity to write about the things I care about.

I would like express my thanks and my gratitude for the zoos that participated in this study, for without them this thesis could not have been completed. I would also like to thank my supervisor for all the idea inputs and for steering me in the right direction, as well as my dear friend Fredrika who went on a trip across Sweden to visit zoos together with me – thank you for being such a good friend.

Lastly I would like to thank my family and friends for their never ending faith and support. I would not be anywhere without you all.

Isabella Grötting,

Uppsala, January 2017.

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9. Appendix 1

SJVFS 2009:92. 6 KAP. PREDATORS

General

1 § Rear enclosure should be available.

2 § Predators that naturally live in cold climates may be held outdoors only if access to wind and rain shelters.

Felines > 100 kg

3 § Requirements for enclosure area as follows:

Indoor enclosure area with display: 100 m², height 3m. The space should be able to be divided.

Stable/night quarters: 6 m²/individual, but at least 24 m². The space should be able to be divided.

Enclosure design: Laying areas in different levels above ground level, vertical tree trunks.

Outdoor enclosure area with display: 1 000 m².

Enclosure design: Raised laying areas, vertical tree trunks, uncultivated ground, alternatively at least half of the ground area softened.

Felines 30 - 100 kg

4 § Clouded leopard may be kept indoors with display certain seasons.

5 § Requirements for enclosure area as follows:

Indoor enclosure area with display: 50 m², height 3 m. The space should be able to be divided.

Stable/night quarters: 5 m²/individual, but at least 20 m², height 3 m. The space should be able to be divided.

Enclosure design: Laying areas in different levels above ground level, vertical tree trunks, climbing opportunities.

Outdoor enclosure area with display: 1 000 m² in a free enclosure, alternatively 500 m² in a cage with 5 m in height.

Enclosure design: Raised laying areas, vertical tree trunks, uncultivated ground, alternatively at least half of the ground area softened, climbing opportunity.

Felines 5 - 30 kg

6 § The species may be kept indoors with display certain seasons.

7 § Requirements for enclosure area as follows:

Indoor enclosure area with display: 25 m², height 3 m. The space should be able to be divided.

Enclosure design: Good climbing opportunities, raised laying areas.

Stable/night quarters: 4 m²/individual, but at least 16 m². The space should be able to be divided.

Outdoor enclosure area with display: 500 m² in a free enclosure, alternatively 300 m² in a cage with 3 m in height.

Enclosure design: Raised laying areas, uncultivated ground, alternatively at least half of the ground area softened, climbing opportunities.

Felines < 5 kg

8 § Tropical species may be kept indoors all year.

9 § Requirements for enclosure area as follows:

Indoor enclosure area with display all year: 25 m², height 2,5 m. The space should be able to be divided.

Indoor enclosure area with display: 10 m², height 2,5 m. The space should be able to be divided.

Enclosure design: Good climbing opportunities, raised laying areas.

Stable/night quarters: 2 m²/individual, but at least 8 m².

Outdoor enclosure area with display: 250 m² in a free enclosure, alternatively 200 m² in a cage with 3 m in height.

Enclosure design: Good climbing opportunities, raised laying areas, uncultivated ground, alternatively at least half of the ground area softened.

Canids and hyenas > 30 kg

10 § Brown hyena may be kept indoors with display certain seasons.

11 § Requirements for enclosure area as follows:

Indoor enclosure area with display: 50 m² and height 3 m for hyena.

Stable/night quarters: 4 m²/individual, but at least 16 m².

Outdoor enclosure area with display: 2 000 m².

Enclosure design: Access to den, raised laying areas, uncultivated ground, digging opportunities.

Canids and hyenas 10 - 30 kg

12 § Aardwolf may be kept indoors with display certain seasons.

13 § Requirements for enclosure area as follows:

Indoor enclosure area with display: 25 m², height 3 m.

Stable/night quarters: 4 m²/individual, but at least 16 m².

Outdoor enclosure area with display: 1 000 m².

Enclosure design: Access to den, raised laying areas, uncultivated ground, digging opportunities.

Canids < 10 kg

14 § Tropical species < 3 kg may be kept indoors all year.

15 § Requirements for enclosure area as follows:

Indoor enclosure area with display all year: 50 m².

Indoor enclosure area with display: 25 m².

Stable/night quarters: 4 m²/individual, but at least 16 m².

Outdoor enclosure area with display: 600 m².

Enclosure design: Access to den, digging opportunities.

American black bear and brown bear

16 § For hibernating bears seasonal storage may take place in the stable/night quarters

17 § Requirements for enclosure area as follows:

Stable/night quarters: 1 box/adult individual with 6 m² each plus 1 extra box. A female with cubs may be held in the same box.

Enclosure design: Climbing opportunities.

Outdoor enclosure area with display: 1 500 m². The space should be able to be divided. The smallest area shall be at least 500 m².

Enclosure design: Digging opportunities, climbing opportunities, access to a pool in all areas.

Protocol Carnivores

Isabella Grötting

Appendix 2

Enclosure assessment – Predators

Zoo:

Date:

Time:

Species:

Sex:

Number of individuals in enclosure:

Life stage of individuals (young, adult, old):

1	**Size** **Total area**											
2	**Space available indoors** ***(YES/NO)*** **If YES, is the indoor area available for visitors?** ***(YES/NO)***	***YES/NO***						***Indoor area available for visitors: YES/NO***				
3	**Indoor/outdoor** **Area size**	**Indoor**						**Outdoor**				
4	**Barriers** **(Example: mesh fence/glass/concrete)** **a) What type?** **b) Placement?** **c) Visibility of enclosure** ***(how much of the enclosure can the visitors see?)***	**a)**		**b)**				**c)**				
5	**How much of the barriers does visitors have access to?** ***(X)***	¼	$^1/_3$	½	$^2/_3$	¾	**Whole**	**Above/from under?**				
6	**Distance to closest enclosure** ***(X)***	**Wall-to-wall**		**Nearby: 2-20m**				**Far off: >20m**				

7	**What species can be found in the closest enclosures?**			
8	**Ground substrate comprises mostly of?** ***Soft ground = NOT concrete/asphalt*** ***(X)***	**Sand/Grass/Concrete?**	**<50% Soft?**	**>50% Soft?**
9	**What does the rest of the ground substrate comprise of?**			
10	**Water enrichment** ***(ex. pool/ dusch/ pond)*** **a) What/which type(s)** **b) Number of enrichment**	**a)**		**b)**
11	**Retreat space available** ***(Animal can walk away from visitors view ex. large rocks/trees/hills)*** ***YES/NO***			
12	**Rain- and** **windshelter** ***(YES/NO, placement, number of shelters)***	**YES/NO**	**Placement**	**Number of shelters**
13	**Laying area** **a) Number + size** **b) Type of bedding + quality** **c) Placement** **d) Roof (*YES/NO*)**	**a)**	**b)**	**c)** **d) *YES/NO***
14	**Climbing possibilities** ***(If YES – What type?)***			
15	**Other resources/ enrichments** ***(other than feed)***			
16	**Group/Individually kept animals?**			

17	**Possibility to perform species specific behaviours:**	**No possibility**		**Small possibility**	**Big possibility**
	• **Behaviour 1**				
	• **Behaviour 2**				
	• **Behaviour 3**				
18	**Are there any amusement places for visitors closeby?** *(If YES, place X)*	**NO**	**YES**		
			Wall-to-wall	**Close by: 2-100m**	**Far off: >100m**

Behavioural needs;

- Felines: Hide, look-out, climb
- Canids: Social interactions, digging, look-out
- Bears: Social interactions, digging, climb

Important resources to double-check;

- Felines: Raised (not directly on ground) lying area, >50% soft ground, *climbing possibilities (NOT >100kg → vertical logs = OK)*
- Canids: Den, raised lying area
- Bears: Pool